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FOCUSED FEASIBILITY STUDY

WORK PLAN

THE NEWTOWN CREEK SUPERFUND SITE

KINGS COUNTY AND QUEENS COUNTY, NEW YORK CITY, NEW YORK

OPERABLE UNIT 2

March 2019

573695

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ACRONYMS

ACO	Administrative Consent Order
AOC	Administrative Settlement Agreement and Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
BAPS	Borden Avenue Pump Station
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
CSO	Combined Sewer Overflow
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Contaminants of Potential Concern
COPEC	Contaminants of Potential Ecological Concern
CWA	Clean Water Act
DDWF	Design Dry Weather Flow
FFS	Focused Feasibility Study
GI	Green Infrastructure
GRA	General Response Action
HQ	Hazard Quotient
LOE	Line(s) of Evidence
LTCP	Long Term Control Plan
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
NCG	Newtown Creek Group
NCP	National Contingency Plan
NYC	New York City
NYCDEP	New York City Department of Environmental Protection
NYSDEC	New York State Department of Environmental Conservation
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
RAO	Remedial Action Objective
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SMIA	Significant Maritime and Industrial Area
SPDES	State Pollutant Discharge Elimination System
TBC	To-be-considered
TEQ	Toxic Equivalent Quotient
USEPA	United States Environmental Protection Agency
WOE	Weight of Evidence
WWFP	Waterbody/Watershed Facility Plan
WWTP	Wastewater Treatment Plant

SECTION 1 - INTRODUCTION

1.1 Introduction

This Work Plan has been prepared by New York City (NYC) outlining the requirements for the development of a Focused Feasibility Study (FFS) for Operable Unit (OU) 2 of the Newtown Creek Superfund Site[1] (Site), located in Kings County and Queens County of New York State.

For the purposes of this FFS, Newtown Creek shall mean Newtown Creek proper and its five branches (or tributaries) which are known as Dutch Kills, Maspeth Creek, Whale Creek, East Branch, and English Kills. A Remedial Investigation and Feasibility Study (RI/FS) is currently underway for the Newtown Creek Study Area[2] addressing conditions in the Creek. The terms "Study Area" and "Site" are defined in the previously executed Administrative Settlement Agreement and Order on Consent (AOC) for the Newtown Creek RI/FS, United States Environmental Protection Agency (USEPA) Region II, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Docket No. CERCLA-02-2011-2011, dated July 7, 2011 (2011 AOC). Two Operable Units have been identified for the Site[2] and are defined as follows:

- Operable Unit 1 addresses site-wide contamination in the Study Area.

- Operable Unit 2 addresses current and reasonably anticipated future releases of CERCLA hazardous substances from Combined Sewer Overflow (CSO) to the Study Area. The definition of OU2 does not include past (historic) releases from CSO discharges to the Study Area.

- The FFS for OU2 is being performed under the Administrative Settlement Agreement and Order on Consent for Focused Feasibility Study (CERCLA Docket No. CERCLA-02-2018-2020 dated December 20, 2018 [effective date January 2, 2019]; 2018 AOC). This Work Plan was prepared based upon the requirements of the Statement of Work attached as Appendix B to the 2018 AOC for the OU2 FFS.

1.2 Focused Feasibility Study Objectives

The objectives of the OU2 FFS identified in the 2018 AOC are as follows:

- Summarize the nature and extent of hazardous substances anticipated to be released to the Study Area from CSO discharges under current and reasonably anticipated future flow conditions as identified in the CSO Long Term Control Plan (LTCP) for Newtown Creek (City of New York, 2017). The LTCP was approved by New York State Department of Environmental Conservation (NYSDEC) in a letter dated June 27, 2018 and supplemented, pursuant to

1 "Newtown Creek Superfund Site" or "Site" shall mean the Study Area and the areal extent of the contamination associated with the Study Area, including facilities upland of the Study Area that are sources of contamination to the Study Area. The Study Area is depicted in Appendix A to the 2011 AOC.

2 "Study Area" shall mean the portion of the Site that encompasses Newtown Creek, including the sediments below the waters of Newtown Creek, and the water column above the sediments, up to and including the landward edge of the shoreline, and including also any bulkheads or riprap containing the water body, except where no bulkhead or riprap exists, in which case the Study Area shall extend to the ordinary high water mark, as defined in 33 C.F.R. Section 328.3(e), of Newtown Creek, and the areal extent of the contamination from such area, but not including upland areas beyond the landward edge of the shoreline (notwithstanding that such upland areas may subsequently be identified as sources of contamination to the water body and its sediments or that such upland areas may be included within the scope of the Site as listed pursuant to Section 105(a)(8) of CERCLA).

NYSDEC's direction, on July 31, 2018. For assessing the future chemical loadings from CSO discharges, the chemical concentrations measured pursuant to the Site RI/FS conducted under the 2011 AOC, will be used.

- Evaluate the impacts of current and reasonably anticipated future releases of hazardous substances from CSOs to the Study Area, including those to human health and/or the environment. The impacts will be assessed using multiple Lines of Evidence (LOE), such as comparison of the measured concentrations of hazardous substances released from CSOs to background concentrations and comparison of the estimated loading of hazardous substances from CSO releases to loadings from other sources. It is anticipated that modeling will be used to assist in assessing these impacts.

- Develop and evaluate alternatives to address current and reasonably anticipated future impacts of hazardous substances released through CSO discharges in the Study Area under flow conditions identified in the LTCP and develop the documentation required to support the selection of an alternative in a Record of Decision (ROD) for OU2 of the Study Area.

1.3 Work Plan Organization

The Work Plan is organized as follows:

- Section 1 contains introduction materials and outlines the OU2 FFS objectives;

- Section 2 presents a description of the Site and history for the CERCLA and Clean Water Act (CWA) programs, and identifies the data and background reference documents used for developing the OU2 FFS;

- Section 3 summarizes the risk assessments conducted for the OU1 and identifies the remedial action objectives (RAO) proposed for the OU2 FFS and the applicable or relevant and appropriate requirements (ARAR) that will be required for any CERCLA activity selected by USEPA for OU2;

- Section 4 summarizes the OU2 FFS development process including the evaluation of general response actions (GRAs), the identification of the remedial alternatives, and the comparative analysis of alternatives that will be conducted to support USEPA's selection of the preferred alternative. It also describes the report that will be prepared to support the OU2 FFS and the community outreach approach;

- Section 5 describes the project management approach, identifies key personnel and their roles, and presents a project organizational chart. The project schedule is also presented in this section; and

- Section 6 lists the references.

SECTION 2 - SITE BACKGROUND INFORMATION

2.1 Site Description

The Site is located in Kings County and Queens County, New York City, New York. The Creek is a 3.8-mile long tidally influenced tributary to the Lower East River and forms a partial border between the boroughs of Queens and Brooklyn of New York City. The Site is within the Newtown Creek Significant Maritime and Industrial Area (SMIA), one of six designated SMIAs in NYC (NCBOA 2012). The Newtown Creek SMIA, at over 780 acres, is the largest SMIA in NYC, and includes portions of the Greenpoint, Williamsburg, Long Island City, and Maspeth industrial areas. The Study Area includes Newtown Creek and its five tributaries, including Whale Creek, Dutch Kills, East Branch, English Kills and Maspeth Creek. Figure 2.1-1a shows the location and extent of the Study Area.

The Study Area receives freshwater flow from groundwater; from various point sources which discharge to the Creek during dry weather and/or wet weather; and from overland flow. The New York City Department of Environmental Protection (NYCDEP) has conducted shoreline surveys (NYCDEP 1991, 2008) and has documented more than 200 municipal and private outfalls along Newtown Creek and its tributaries. Some of these outfalls are abandoned and are no longer in use. Permits for some point source discharges were issued by the NYSDEC under New York State's State Pollutant Discharge Elimination System (SPDES), which has been approved by the USEPA for controls of surface water and stormwater discharges in accordance with the CWA. SPDES permitted discharges to the Creek include private point source discharges from upland properties, which discharge treated effluent from groundwater remediation and dewatering systems, stormwater discharge from secondary containment systems, and industrial sites. Municipal discharges, such as CSOs, treated effluent from the Wastewater Treatment Plant (WWTP), and municipal separate storm sewer systems (MS4s), are also SPDES permitted discharges. In addition to the SPDES permitted discharges, stormwater is discharged from private outfalls for sites adjacent to and near the Creek.

In the past, the land use around the Study Area was predominantly industrial and remains such, with some interspersed commercial, mixed use and residential land uses (NYCDEP 2011). Primary land uses around Newtown Creek are expected to remain largely industrial in the future, as the Site is within the Newtown Creek SMIA. Notably, the exodus of heavy industry from New York City and the enactment and enforcement of the CWA have led to a reduction in discharges of contamination into the waters of the City, including the Study Area.

2.2 Site History and Progress

Newtown Creek is subject to both CERCLA and CWA regulation. The activities of both of these regulatory programs for Newtown Creek are further described below.

2.2.1 Site History and Progress – CERCLA

The Site was listed on the USEPA National Priorities List in 2010. The Newtown Creek SMIA experienced rapid industrial development during and beyond the mid-1800s. At various times, industrial activities along the banks of the Creek have included oil refineries, manufactured gas plants, petrochemical plants, fertilizer and glue factories, copper-smelting and fat-rendering plants, aluminum plants, sugar refineries, shipbuilders, hide tanning plants, canneries, sawmills, paint works, and lumber and coal yards and fuel oil depots (USEPA 2011).

Beginning in the late 1800s and continuing into the 1930s, the Creek was widened, deepened, and lined with bulkheads to accommodate the growing traffic resulting in natural drainage conditions being converted to one that is governed largely by engineered and institutional systems (USEPA 2011). Current land use along Newtown Creek and its tributaries are still industrial, including but not limited to petroleum bulk storage facilities; liquefied natural gas facilities; recycling facilities for asphalt, metals and construction and demolition waste; manufacturing facilities; warehouses; transportation and transportation infrastructure including rail and highways; utilities;, and municipal facilities. Releases of non-aqueous phase liquids/oil to the Creek through oil spills and illegal oil releases have occurred and are documented on the NYSDEC spills website (NYSDEC 2018).

The USEPA has identified six respondent parties to conduct the RI/FS for the Site. These include the Newtown Creek Group (NCG), consisting of the following five respondents: Phelps Dodge Refining Corporation, Texaco Inc., BP Products North America Inc., Brooklyn Union Gas Company d/b/a National Grid New York and Exxon Mobil Corporation. NYC has also been identified as a respondent for the Site. The respondents have been responsible for collecting data for the ongoing development of the RI/FS. The Baseline Human Health Risk Assessment (BHHRA) and Baseline Ecological Risk Assessment (BERA) sections of the RI/FS have been completed.

2.2.2 Site History and Progress – CWA (CSO LTCP)

Municipal point source discharges to the Creek include combined sewer overflows, stormwater discharge from permitted MS4 and treated effluent from the Newtown Creek WWTP. This facility, New York City's largest wastewater treatment plant, commenced operation in 1967 and was upgraded in 1998 to meet secondary treatment standards. The WWTP has a permitted wet-weather capacity of 700 million gallons per day (MGD) and currently serves one million residents with a projected population of 1.33 million by 2045, covering a drainage area of more than 15,000 acres.

Over several decades NYCDEP has implemented measures to reduce the amount of CSO flows to the Site in accordance with the CWA, resulting in the reduction of bacteria levels and improvements in dissolved oxygen concentrations in Newtown Creek. As discussed below, the CSO control measures, including the implementation of best management practices as well as volumetric reductions of CSO discharge to Newtown Creek, have reduced the mass of CERCLA contaminants of potential concern (COPC) discharged to Newtown Creek from CSO discharges.

Beginning in 1990, NYCDEP undertook CSO planning for Newtown Creek through its Newtown Creek Water Quality Facility Planning Project. NYCDEP's planning efforts focused on quantifying and assessing the impacts of CSO discharges to Newtown Creek and its tributaries. Based on the conclusions of this initial study, NYCDEP recommended additional studies and work tasks in its Final Facility Plan Report, submitted to NYSDEC in 2003. In 2005, NYSDEC issued a NYSDEC Clean Water Act Administrative Consent Order (NYSDEC ACO) to NYC to address CSO discharges including those in the Newtown Creek Study Area. Pursuant to the NYSDEC ACO, in 2011 NYCDEP submitted a waterbody/watershed facility plan (WWFP) addressing CSO discharges to Newtown Creek to NYSDEC (NYCDEP, 2011). The WWFP, which NYSDEC approved in 2012, included an analysis of operational and structural modifications targeting the reduction of CSOs and improvement of the overall performance of the collection and treatment system within the Newtown Creek watershed. In 2012, NYSDEC modified the existing NYSDEC ACO to include projects approved by NYSDEC in the WWFP. Pursuant to the WWFP and modified NYSDEC ACO, NYCDEP undertook the following projects to address CSOs discharged to the Creek:

- Upgrades to and ongoing operation of the Brooklyn/Queens pump station at up to 400 MGD during wet-weather;
- Construction of bending weirs and floatables control for regulator sites at or around the four largest (by volume) CSO outfalls for Newtown Creek; and
- Construction of an enhanced aeration system for Lower English Kills and East Branch (the aeration system in Upper English Kills was placed in operation in 2009, prior to the WWFP).

Under the NYSDEC ACO, NYCDEP was required to prepare a LTCP for Newtown Creek. The baseline condition to be met under the LTCP included the following:

- Anticipated sanitary flow for the 2040 population, treatment capacity for the Bowery Bay WWTP (up to 300 MGD [2 x design dry weather flow {DDWF}]);
- Treatment capacity for the Newtown Creek WWTP (up to 700 MGD [> 2 x DDWF]);
- Cost effective low-lying sewer diversions and regulator modifications in the Bowery Bay interceptor system; and
- Throttle gate at the Kent Avenue Interceptor.

The WWFP identified additional CSO controls to be considered during development of the LTCP, such as NYCDEP's Green Infrastructure (GI) investments, which would result in additional reductions in CSO flow volumes. Specifically, by 2030 NYCDEP is projected to achieve an 83 million gallons per year reduction in CSO flows, based on 2008 rainfall amounts, from constructed or planned GI in the Newtown Creek watershed. The reduction from GI will be achieved primarily through retention and detention practices on public and private property from impervious areas discharging to the Newtown Creek combined sewer system.

The LTCP builds upon the WWFP and GI implementation projects and will further reduce bacteria and improve dissolved oxygen concentrations in Newtown Creek by significantly reducing the volume of CSO discharges to the Creek. The LTCP was submitted in June 2017 and approved by NYSDEC in 2018 (NYCDEP 2017). The LTCP requires the design, construction, and operation of the following system components:

- Expansion of the Borden Avenue Pump Station (BAPS) to 26 MGD to provide an additional 75% control of the annual CSO volume at Outfall BB-026.
- Construction of a CSO Storage Tunnel sized to provide approximately 62.5% additional control of outfalls NC-015, NC-083 and NC-077. The dimensions and route for the tunnel will be further evaluated and finalized during upcoming NYCDEP planning and design efforts.

Figure 2.2-1 shows that the impact of the LTCP, which will achieve an approximately 72% reduction in the CSO volumes discharged to Newtown Creek as compared to pre-WWFP levels (based on 2008 rainfall amounts and the estimated 2040 future population).

2.3 Background Document and Data to be used for Development of OU2 FFS

2.3.1 Background Documents from the OU1 RI/FS

The OU2 FFS will incorporate information previously developed for the Study Area. Information developed as part of the OU1 RI/FS include the following documents:

- BHHRA - finalized in May 2017
- BERA - finalized in October 2018

The risk assessment documents will be used to identify the COPCs for human health and the environment that will be carried through the FFS.

2.3.2 Background Documents from the LTCP Program

The OU2 FFS will be based on information developed as part the LTCP planning program which details and supports NYCDEP's CSO control program. In developing the OU2 FFS, information from the following documents will be incorporated into the FFS:

2.3.2.1 Newtown Creek LTCP

The LTCP detailed the development of NYCDEP's CSO control program and outlined the program's water quality benefits. As part of the development of the LTCP a number of alternative approaches to addressing CSO overflows into the Study Area were screened and evaluated. This analysis will be considered during the identification of remediation alternatives.

2.3.2.2 LTCP Modeling Reports

Consistent with federal CSO policy, the Newtown Creek LTCP relied upon a demonstration approach whereby modeling was used to predict improvements to Newtown Creek water quality resulting from CSO controls. NYCDEP will utilize the sewer system, hydrodynamic and sediment transport/dissolved oxygen models that were developed to support the LTCP demonstration approach, to provide input information for the chemical recontamination potential evaluations NYCDEP will conduct for the OU2 FFS. The sewer system, hydrodynamic and sediment transport/dissolved oxygen models are described in the LTCP modeling report (NYCDEP, 2018).

2.3.2.3 LTCP Modeling Peer-Review Reports

The hydrodynamic and sediment transport/dissolved oxygen models were peer-reviewed during several daylong in-person meetings throughout the LTCP model development and application process. The peer-reviewers of NYCDEP's Newtown Creek hydrodynamic and sediment transport/dissolved oxygen models prepared a written report documenting and summarizing their findings (Blumberg et al., 2017). In addition, a peer-reviewed chemical recontamination model was developed for Gowanus Canal (Blumberg, et al., 2015) and this model will be utilized in developing the OU2 FFS analysis. The peer review reports are included in the Section 6 reference list and their use is subject to USEPA approval.

2.3.3 Data Used for OU2 FFS

Data has been collected to support various programs for the LTCP and OU1 RI/FS. Fieldwork for the OU1 RI/FS was conducted in two phases, under the oversight of the USEPA, to determine the nature and extent of contamination in the Study Area. The sampling work included surveys of physical and ecological characteristics of Newtown Creek, as well as sampling of surface water, surface sediments, subsurface sediments, groundwater, point sources, air and biota. Samples were analyzed for various CERCLA chemicals of concern including Polycyclic Aromatic Hydrocarbons (PAH), Polychlorinated Biphenyls (PCB), and metals. Data collected under the USEPA approved Work Plan will be used to assess the COPC concentrations in point sources, Study area and reference/background areas. This data will be also primarily used for the evaluation and chemical modeling outlined in the LOE approach described in Section 4.3.

To support the LTCP, NYCDEP collected data in the Study Area and from municipal point sources (CSOs, MS4s and WWTP treated effluent). This sampling program included water quality measurements in the Creek, CSOs and East River. The data collected by NYCDEP followed USEPA-approved methods to characterize the discharges. For point sources, data collected by the NYCDEP included the same storms sampled for the RI/FS at the same locations. The data was used to develop the models used for LTCP and will be used in the OU2 FFS to compare the levels of COPCs in CSO discharges to the levels of COPCs measured in data collected for the OU1 RI/FS. Biases or significant differences in the data will be discussed with the USEPA to develop a path forward for data use. Attachment A provides a list of the data used for developing the models listed in the Work Plan. A discussion of the data used will be included in the OU2 FFS report.

SECTION 3 - RESULTS OF RISK ASSESSMENTS AND ESTABLISHMENT OF CLEANUP OBJECTIVES

3.1 Risk Assessment Summary and COPC/COPEC list for the OU2 FFS

USEPA has approved and finalized the baseline human health and baseline ecological risk assessments for the Study Area. These risk assessments identify the COPCs and contaminants of potential ecological concern (COPEC) for the Study Area. The findings of the risk assessments are summarized below along with the chemicals that are potential COPCs for the Study Area. The FFS developed for OU2 will focus on these COPCs/COPECs.

3.1.1 Summary of BHHRA Conducted for OU1

The BHHRA assesses potential risks to human health from exposure to chemicals found in surface sediments, surface water, fish, crab tissue, and air in the Study Area, for potential current and future exposure levels. Potential receptors include boaters, swimmers, recreational anglers and crabbers, sailboat users, residents, and occupational workers. Two types of adverse health effects were evaluated in the BHHRA: potential incremental risk of developing cancer due to exposure to chemicals and the hazards associated with non-cancer health effects.

Risk characterization for the Study Area shows that an unacceptable risk is present in Newtown Creek from consumption of fish and crabs. Fish and crab consumption results in a lifetime excess cancer risk that exceeds the USEPA acceptable cancer risk range (Anchor 2017). Non-cancer hazards above the USEPA hazard quotient (HQ) threshold are also associated with consumption of fish and crabs from Newtown Creek (Anchor 2017). For Newtown Creek, total non-dioxin-like PCB congeners, total PCB congener toxic equivalent quotients (TEQs), and total dioxin/furan TEQs are the only COPCs that have cancer risks above the USEPA acceptable range and HQs above the non-cancer threshold of 1 (Anchor 2017).

Risk characterization was conducted for reference areas selected by USEPA for the Study Area (Anchor 2016). The four urban reference areas represent the following types of areas: limited industrial sources and CSOs; both industrial sources and CSOs; limited industrial sources only; and limited CSO only. When data from the four types of areas were combined, total risks and hazards associated with consumption of fish and crab tissue from the reference areas were also elevated, however, the associated risk levels were two to four times lower than risks and hazards from the Study Area. Reference area cancer risks and non-cancer hazards indicate that certain COPCs in the species consumed by people fishing and crabbing in the Study Area may originate in the wider New York-New Jersey urban area and not just the Study Area itself (Anchor 2017).

Overall, the results of the BHHRA indicate that potential consumption of Study Area fish and crabs poses an elevated risk to human health. The primary COPCs for human health were PCBs and dioxins/furans.

The COPCs identified by the BHHRA (total non-dioxin-like PCB congeners, total PCB TEQs, and total dioxin/furan TEQs) will be assessed in the OU2 FFS.

3.1.2 Summary of BERA Conducted for OU1

The BERA assessed the risks associated with the Study Area for representative ecological receptor groups, including aquatic plants, invertebrates, fish, and aquatic-feeding birds and mammals. The receptor groups were evaluated by characterizing risks to specific receptors and surrogate species within the group, including aquatic macrophytes, zooplankton, benthic macroinvertebrates, bivalves, blue crab, amphibians and reptiles, striped bass, mummichog, spotted sandpiper, green heron, blackcrowned night heron, double-crested cormorant, belted kingfisher, and raccoon.

Both quantitative and qualitative LOEs were used to assess risk from exposure to COPECs in Newtown Creek. The BERA applied a weight of evidence (WOE) approach to incorporate the individual LOEs into an overall evaluation of risk.

Quantitative LOEs included:

- Direct exposure to COPECs in surface water, surface sediment, and porewater;
- Direct and indirect exposure to COPECs in invertebrate and fish tissue;
- Indirect exposure of fish to COPECs in sediment and prey through diet;
- Indirect exposure of wildlife (birds and mammals) to COPECs in surface water, sediment, and prey through diet;
- Benthic community analysis;
- Sediment toxicity testing;
- Analysis of COPEC bioavailability; and
- Laboratory bioaccumulation testing.

Qualitative LOEs included:

- Observations of fish and crab presence/absence, richness, and diversity;
- Observations of mammal presence/absence, and bird presence/absence, richness, and abundance;
- Observation of aquatic macrophyte presence/absence; and
- Observation of amphibian and reptile presence/absence.

Newtown Creek surface water, sediment, porewater, and biota tissue were extensively characterized, increasing the overall relevance, strength, and reliability of the LOEs. Site-specific studies used widely accepted methods that were well developed and have been used for many years within the scientific community, including sediment toxicity testing, benthic community studies, and the use of simultaneously extracted metals-acid volatile sulfate (SEM-AVS) to evaluate bioavailability.

Surface water was evaluated as an exposure pathway for aquatic plants, zooplankton, bivalves, benthic macroinvertebrates, epibenthic macroinvertebrates (blue crab), and fish. For surface water COPECs, all HQs were less than 1.0 with the exception of cyanide. Cyanide concentrations were elevated above the Study Area range in 2 of the 360 surface water samples resulting in an HQ of 1.1. Because cyanide was only elevated at two locations and because the magnitude of the HQ was so low, cyanide will not be assessed in the OU2 FFS.

Risks to bivalves, benthic macroinvertebrates, blue crab, and fish were evaluated by comparing bioaccumulative COPEC concentrations in their tissues to literature-based critical body residues. For sessile organisms (bivalves and benthic macroinvertebrates), HQs exceeded 1.0 for PAHs and PCBs, with the highest magnitude of risk in the Turning Basin and English Kills. For resident fish with limited mobility (mummichog), HQs exceeded 1.0 for copper, with the highest magnitude of risk in Dutch Kills. For more mobile or migratory receptors (blue crab and striped bass), HQs exceeded 1.0 for dioxins/furans, PCBs, and copper on a Study Area-wide basis. Risks to wildlife (i.e., piscivorous birds, sediment-probing birds, and omnivorous mammals) were evaluated through dietary intake exposure modeling. There is evidence of harm for sediment-probing birds (e.g., spotted sandpiper) and for piscivorous birds (e.g., herons, cormorants, and kingfisher) from PCBs, with the highest magnitude of risk in Dutch Kills. There is also evidence of harm for sediment-probing birds from copper and lead, with the highest magnitude of risk in Dutch Kills, Maspeth Creek, and English Kills.

Evaluation of porewater COPECs showed that there is evidence of harm to benthic macroinvertebrates in the Turning Basin and English Kills from exposure to porewater PAHs at concentrations in excess of chronic toxicity thresholds. Porewater metals also exceeded chronic toxicity thresholds at some locations, but the SEM-AVS analyses indicated that the metals were not bioavailable.

Five areas within Newtown Creek were identified with multiple assessment endpoints and receptor groups as being associated with HQs exceeding 1.0. These areas include Dutch Kills, English Kills, East Branch, Maspeth Creek, and the Turning Basin. The multiple LOEs contributing to exceedances within these areas are associated with the highest concentrations of COPECs at the Study Area in both sediment and porewater.

Overall, the results of the BERA (Anchor 2018) indicate that Study Area sediments, particularly in the Turning Basin and most of the tributaries, are toxic to benthic invertebrates and present exposure risks for bivalves, blue crabs, fish, and birds. The primary COPECs driving risk were PAHs, PCBs, and copper, with additional risk from dioxins/furans and lead. The conclusions regarding the risks associated with exposure to the COPECs as summarized above are well supported and can be used to optimize risk management decisions for the Study Area.

The COPECs identified by the BERA (i.e., PAHs, PCBs, dioxins/furans, copper, and lead) will be assessed in the OU2 FFS.

3.2 Development of RAOs

Remedial action objectives consist of medium specific or operable unit-specific goals for protecting human health and the environment (USEPA 1988). These objectives are developed based on available information and standards, such as site-specific risk assessment, background concentrations, ARARs, and to-be-considered guidance (TBCs).

The RI/FS for the Study Area is still in progress and no RAOs have been established for OU1.During the development of the OU2 FFS, the City will meet with USEPA to discuss and develop the RAOs for OU2. The OU2 RAOs will be finalized in conjunction with USEPA input and are subject to USEPA approval.

3.3 Identification of ARARs and TBCs

As discussed in Section 3.2, RAOs are specific goals to protect human health and the environment. These objectives are based on available information and standards, such as ARARs and TBCs. ARARs are established local, state, and federal cleanup requirements that are legally applicable or relevant and appropriate to the hazardous substance or manner of release; TBCs are other related guidance documents that can inform the decision-making process but may not have the same force as ARARs such as advisories, criteria or guidance issued for a specific release.

- **Applicable requirements** means those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. [40 CFR § 300.5]. A requirement is applicable if the specific terms or jurisdictional prerequisites of the law or regulation directly addresses the circumstances at the site. [*See* 53 FR 51437 Dec.21, 1988]
- **Relevant and appropriate requirements** means those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate. [40 CFR § 300.5]

ARARs are classified as chemical-specific, location specific and action specific requirements. Chemical specific ARARs define acceptable exposure levels and are used in establishing preliminary remediation goals. Location-specific ARARs set restrictions on activities within specific locations such as floodplains or wetlands; and action-specific ARARs may set controls or restrictions for particular treatment and disposal activities related to the management of hazardous wastes (USEPA 1988). For the purposes of the OU2 FFS, potential chemical- and location-specific ARARs will be identified on the basis of the existing site data. In addition to federal ARARs, relevant state and local ARARs will be also identified. Other federal and state criteria, advisories, and guidance and local ordinances will be considered, as appropriate, in the identification of the ARARs and TBCs.

A preliminary list of chemical-specific, location-specific, and action-specific ARARs and TBCs will be identified and incorporated in the FFS. In addition, USEPA guidance documents including the following, will be reviewed for assistance in identifying potential ARARs and TBCs:

- CERCLA Compliance with Other Laws Manuals: Part I USEPA 540/G-89/006, OSWER 9234.1-01, NTIS: PB90-272535CDH, August 1988;
- CERCLA Compliance with Other Laws Manuals: Part II USEPA 540/G-89/009, OSWER 9234.1-02, NTIS: PB90-148461INZ, August 1989;
- Section XII: Applicable or Relevant and Appropriate Requirements" from CERCLA/ Superfund Orientation Manual TIO, USEPA 542/R-92/005, NTIS: PB93-193852, October 1992; and
- ARARs Fact Sheet: Compliance with the Clean Air Act and Associated Air Quality Requirements OSWER 9234.2-22FS, September 1992.

In addition, USEPA guidance for the identification of state ARARs (OLEM Directive 9200.2-187) will be reviewed. The list of ARARs and TBCs will be finalized in conjunction with USEPA and New York State for incorporation into the OU2 FFS.

SECTION 4 - GENERAL RESPONSE ACTIONS AND ALTERNATIVE SCREENING

General Response Actions describe different types of actions that will satisfy RAOs when implemented individually or in combination (USEPA 1988). Each GRA is associated with one or more applicable technology group. Applicable GRA process options are selected based on an understanding of the characteristics (physical and chemical) of the pertinent contaminated medium and the technologies that are available to address that medium. The universe of potentially applicable technology types and process options are reduced by screening the technologies and process options with respect to technical feasibility. Technologies passing the initial screening process are further evaluated as to technical feasibility, implementability, and cost. Technologies are then assembled as potential remedial alternatives for achieving RAOs. The alternatives developed and screened are conceptual and the characteristics are approximate and for comparison purposes only. Design details would be addressed during the remedial design.

4.1 Selection of Remedial Alternatives

During the development of the Newtown Creek LTCP, NYCDEP evaluated several alternatives for controlling CSO discharges to the Creek intended to meet the water quality criteria set forth in the NYSDEC AOC for the Study Area. Section 8 of the NYSDEC-approved LTCP document for Newtown Creek describes the City's evaluation of CSO control alternatives which includes the CSO control measures and technologies considered by the City for Newtown Creek. The categories of CSO control measures initially considered for Newtown Creek included: Source Control, System Optimization, CSO Relocation, Water Quality/Ecological Enhancement, and Treatment and Storage. For screening these technologies, NYCDEP followed a thorough evaluation process including meetings and workshops for NYCDEP Bureau Executives and NYCDEP operational and engineering staff along with periodic presentations to NYSDEC and USEPA staff.

In the LTCP, preliminary evaluations of CSO control measures included initial estimates of costs and projected water quality improvements with more promising technologies evaluated in greater detail to develop retained CSO control measures. Retained CSO controlled measures were further evaluated and ultimately used to develop basin-wide alternatives. Evaluation criteria for screening CSO control technologies included: performance, construction impacts, cost, technical feasibility, expansion potential, implementation, environmental considerations, and community acceptance. Control methods were evaluated by their relative costs, complexity, and effectiveness.

The OU2 FFS will include a summary of the CSO control technology screening process and results to document this step prior to evaluating, and comparing the retained alternatives. As specified in the 2018 AOC, the remedial alternatives to be evaluated in the OU2 FFS will include, but not necessarily limited to, the following:

- Alternative 1 - No Action. The No Action Alternative is retained for comparison purposes in the comparative analysis process. The evaluation of this alternative will include consideration of CSO remedial controls from several previously required projects that are currently in various stages of construction or have been completed. These will be discussed in the OU2 FFS report.

- Alternative 2 –No Further Action. This alternative involves implementation of the CSO control measures identified in the LTCP, in addition to completion of construction of the ongoing control systems and GI program. The program identified in the LTCP proposes construction of a storage tunnel for the largest three CSO outfalls (NCB-015, NCQ-077 and NCB-083) as well as a pump station upgrades for CSO outfall BB-026 to reduce CSO discharges to the Creek.

- Alternative 3 – 100% CSO Control. This alternative would be similar to, but more expansive than, the proposed storage system being evaluated under Alternative 2. Under this alternative, all CSOs discharges to Newtown Creek would be controlled. In addition to the completion of construction of the ongoing control systems and GI program, this alternative would eliminate the BAPS expansion but would involve the construction of a larger diameter deep tunnel for full capture of flows from all CSO outfalls discharging to Newtown Creek.

4.2 Evaluation of Remedial Alternatives

Under this task the retained alternatives will be evaluated using seven of the nine criteria established in the National Contingency Plan (NCP) including a careful study of circumstances that may prevent an alternative from achieving the RAOs set forth for the Study Area. The two modifying criteria will be evaluated following completion of the FFS.

The nine NCP criteria are divided into three groups shown below.

Threshold Criteria

1. Overall protection of human health and the environment

2. Compliance with ARARs

Primary Balancing Criteria

3. Long-term effectiveness and permanence

4. Reduction of toxicity, mobility or volume

5. Short-term effectiveness

6. Implementability

7. Cost

Modifying Criteria

8. State acceptance

9. Community acceptance

The threshold criterion of assessing the overall protection of human health and environment will be evaluated using a multiple LOE approach. This approach, described in Section 4.4, is necessary because chemical-specific preliminary remediation goals have not yet been developed for the Study Area. A multiple LOE approach, which includes the assessment of CSOs impacts using the reference and background waterbodies and background sources, will be used. In addition to this, impact of CSO solids on the surface sediments of the Creek will be assessed using data analysis and modeling. Details of the LOE approach are discussed in Section 4.4.

4.3 Comparative Analysis of Remedial Alternatives

Following the initial evaluation of each alternative, a comparative analysis between alternatives will be conducted to assess the relative performance of each alternative with respect to each of the initial seven evaluation criteria. This analysis will help in identifying the advantages and disadvantages of each alternative relative to one another and will assist in the remedy selection decision making process. As per USEPA guidance (USEPA 1988) the threshold criteria must be met by any alternative in order for it to be eligible for remedy selection. The primary balancing criteria will be discussed at length because major tradeoffs among alternatives will be most likely determined by these criteria.

The State and community acceptance criteria will be addressed in the ROD once formal comments on the OU2 FFS report have been received and final remedy decision has been made.

4.4 Multiple Lines of Evidence Approach

To assess the impact of CSO discharges on Newtown Creek, a multiple LOE approach will be used. This is necessary because the RI/FS for the Study Area is in development and the preliminary remediation goals for the Study Area have not been developed. Because of this, a direct risk-based decision-making approach cannot be applied to this OU2 FFS. Accordingly, and as detailed below, it is appropriate to utilize an LOE approach to assess the impact of CSO discharges to the Study Area.

4.4.1 Comparison of COPCs in CSO Discharge with Background and Reference Areas

Information from background and reference areas to the Study Area will be used as a line of evidence to put the hazardous substance discharges from CSOs into context. The COPC concentrations in CSO discharges will be compared to the COPC concentrations in the background and reference area sites. This comparison will provide an assessment of the relative magnitude of COPCs in CSO discharge. This comparison will be a conservative line of evidence as it does not account for dilution of CSO discharges from exchanges with the East River when the discharge enters the Study Area.

The background and reference areas proposed for this assessment include the fourteen waterbodies selected by USEPA to represent the urban nature of the NY harbor area for OU1. For the development of the risk assessment for the Study Area, pursuant to a USEPA approved Work Plan, sediment samples were collected from fourteen waterbodies in NYC to determine the levels of COPCs in urban sites with varying levels of industrial and municipal discharges (Anchor 2012). Six waterbodies, including the Brooklyn Navy Yard, Lower East River, Upper East River, Steinway Creek, Westchester Creek, and Flushing Creek, are connected to the East River watershed, and the seven other waterbodies, including Fresh Creek, Gerritsen Creek, Head of Bay, Hendrix Creek, Mill Basin, Sheepshead Bay, and Spring Creek, are connected to the Jamaica Bay watershed. Coney Island Creek is connected to the Lower New York Harbor, but is adjacent to Jamaica Bay. These fourteen water bodies were considered by USEPA as background and reference sites for the Study Area.

4.4.2 Comparison of Loads from CSOs

One approach to assessing the magnitude of a source on the Study Area as a whole, is calculation of the contaminant loading, defined as a unit of mass over a unit of time (kg/year or tons/year). This calculation takes into account the flow rate of a source and the associated chemicals in that discharge. To assess the impact of CSOs on Newtown Creek, COPC loading from CSOs will be compared to the background sources to the Creek. There are several background sources to the Study Area. Newtown Creek is a tidally influenced tributary to the East River and the East River is considered one of the background inputs to the Study Area. Other background sources to the Study Area include, but are not limited to, atmospheric deposition, overland flow, MS4s and direct discharges. Loads for various background sources will be calculated using available data collected for the Study Area. This information will be used as a line of evidence to put the hazardous substance discharges from CSOs into context as inputs to the Study Area.

The sewer system model, described in Section 4.4.3.1, developed by NYCDEP for the LTCP, will be used to calculate the flow rate from CSO discharges under current conditions and the CSO reduction scenarios selected by the LTCP. Loads for CSOs will be calculated using these flow rates and the chemical concentrations measured in point source discharges for the RI/FS (and other sources as appropriate and needed).

For estimating the COPC loads from the East River, an estimate of the net yearly East River solids deposited in Newtown Creek will be used along with an estimate of chemical concentrations in East River solids. Newtown Creek experiences tidal exchange with the East River twice daily; the net solids deposition of East River solids is a measure of the net East River input to the Creek. The chemical concentrations measured in the surface water in East River and at the mouth of Newtown Creek (first transect) for the OU1 RI/FS will be used to estimate the expected levels of chemicals on East River solids.

The loads from atmospheric deposition will be calculated using an approach consistent with the Contaminant Fate and Transport and Bioaccumulation (CARP 2007) model that was developed for the New York-New Jersey Harbor urban estuary. Atmospheric data from monitoring stations around Newtown Creek will be used to develop chemical-specific atmospheric flux which will be multiplied with the Creek surface area to develop a contaminant loading estimate.

For other background sources such as overland flow, direct discharges and MS4s, data collected for the OU1 RI/FS will be used to estimate the expected levels of chemicals in the various sources. This information along with the estimated volumetric discharge from the point source model will be used to calculate the loads from these sources.

The annual CSO loads under current conditions and post LTCP reduction conditions will be compared with the loads from background sources to develop an assessment of the relative impact of CSOs on the Study Area.

4.4.3 Assessment of Post Remedial Impact of CSOs on the Study Area

To assess the future impact of CSO discharges on the Creek after the OU1 remediation project is completed, a chemical transport model, described in Section 4.4.3.4, will be developed and applied. The chemical transport model will be representative of rainfall conditions for 2002-2011. Consistent with the statement of work, the chemical transport modeling will evaluate the three remedial alternatives: No Action, No Further Action, and 100% Control of CSO Discharges to the Creek. The selected rainfall conditions and future loading conditions were previously defined and approved during the City's CSO LTCP effort (City of New York, 2017). The chemical transport model requires spatially aggregated information from previously developed, calibrated/validated and peer-reviewed hydrodynamic and sediment transport models. Each of the models are described in the following subsections.

4.4.3.1 Sewer System Modeling

To evaluate the expected future impact of CSO discharges on Newtown Creek after OU1 remediation has been completed, estimates of point source chemical loadings will be developed. Point source loadings will be estimated based on the CSO, stormwater, and direct drainage flows to the Creek calculated by the City's time-variable sewer system model developed for Newtown Creek (City of New York, 2018). The City's sewer system model for Newtown Creek was previously shared with USEPA in a geo-neutral format for use in the RI/FS. The CSO, stormwater, and direct drainage flows calculated with the City's sewer system model for Newtown Creek are passed to the hydrodynamic, sediment transport and chemical transport models and are used for loading calculations.

The source code underlying the City's sewer system model for Newtown Creek is the commercial software product, InfoWorks CS™ (IW) version 10.5. The application of InfoWorks to the Newtown Creek and Bowery Bay WWTP service areas draining to Newtown Creek includes modeling plant headworks, interceptors, branch interceptors, major trunk sewers, all sewers greater than 48 inches in diameter plus other smaller, significant sewers, and control structures such as pumping stations, diversion chambers, tipping locations, regulators, and tide gates. While InfoWorks development and calibration for Newtown Creek spanned many years, the most recent validation in 2015 included collection of additional flow meter and inclinometer measurements. The approach to analyzing the data from this flow metering program followed the approach documented in the peer-reviewed report published by the Water Environment Research Federation (WERF) in 2015 entitled *NYCDEP CSO Metering Pilot Study***.**

After the 2015 validation of Newtown Creek InfoWorks, it was necessary to further update existing condition and future baseline versions of the model as new information became available such as infrastructure modifications and drainage area refinements as described in the LTCP developed for the Study Area (City of New York, 2018).

The baseline model as applied for the LTCP will be used for future impact assessment purposes. The baseline sewer system model provides point source flow information for use in the calculation of point source loadings and for input to the hydrodynamic, sediment transport, and chemical transport models. These other models are described below.

4.4.3.2 Hydrodynamic Modeling

To evaluate the expected future impact of CSO discharge on Newtown Creek after OU1 remediation has been completed, hydrodynamic transport model outputs will be developed for use in chemical modeling as described in Section 4.4.3.4. The hydrodynamic transport model outputs will be spatially aggregated to the resolution of the computational grid of the chemical model and passed to the chemical transport model. The model inputs will include: point source and groundwater discharge volumes and advection and diffusion volumetric exchanges between the aggregated model grid cells of the chemical recontamination potential model.

The three-dimensional and time-variable hydrodynamic transport model that will be used to develop these outputs (City of New York, 2018) has been peer-reviewed (Blumberg et al., 2017) and was further vetted within the modeling community (Kim et al., 2018). Further, the hydrodynamic transport model was presented to USEPA on October 21, 2016.

The source code underlying the Newtown Creek hydrodynamic model is ECOM for Estuarine and Coastal Ocean Model. The hydrodynamic model computational grid including ten vertical sigma layers includes longitudinal and lateral segmentation in the Harlem River, Upper and Lower East River, and within Newtown Creek and its tributaries. Inside of Newtown Creek and its tributaries, the hydrodynamic model grid segmentation is nearly identical to segmentation currently in use by USEPA for Newtown Creek RI modeling. The point source flows were estimated by the InfoWorks model for CSOs, stormwater, and direct drainage prepared for the LTCP and shared with USEPA for use in the RI/FS in a geo-neutral format. Groundwater flows were estimated by using the seepage data collected by NYCDEP for the Study Area. The hydrodynamic model considers the physical mixing induced by the aeration systems in English Kills and East Branch. The hydrodynamic model calibration and validation includes the periods 1/1/2012 to 9/30/2015 and 1/1/2016 to 9/30/2016, respectively.

4.4.3.3 Sediment Transport Modeling

To evaluate the expected future impact of CSO discharges on Newtown Creek after OU1 remediation has been completed, sediment transport model outputs will be developed for use in chemical transport modeling. The sediment transport model outputs that will be spatially aggregated to the resolution of the computational grid of the chemical model and passed to the chemical transport model include: point source organic and inorganic solids concentrations, total suspended solids, the fraction of particulate organic carbon in the water column and sediment bed, depositional flux, and erosional flux.

The three-dimensional and time-variable sediment transport model that will be used to develop these outputs is described elsewhere (City of New York, 2018) and has been peer-reviewed (Blumberg et al., 2017). The source code underlying the Newtown Creek sediment transport model is Row Column AESOP. Like the hydrodynamic model, the sediment transport model computational grid includes ten vertical sigma layers and longitudinal and lateral segmentation in the East River, but omits the Harlem River and a portion of the Upper East River. Within Newtown Creek and its tributaries, the sediment transport model computational grid segmentation is identical to the hydrodynamic model grid segmentation and is nearly identical to segmentation currently in use by USEPA for Newtown Creek RI modeling. The sediment transport model also includes sediment bed segmentation matching the longitudinal and lateral resolution of the water column for a 10 cm depth.

The sediment transport model includes a dissolved oxygen/eutrophication model which calculates primary produced (algal) and detrital particulate organic carbon and dissolved organic carbon. The model calculations include inorganic suspended solids modeled as one cohesive size class, combined organic-inorganic flocs. The single cohesive grain size applied focused on the transport of point-source inorganic and carbonaceous solids, appropriate for the OU2 FFS. The model represents most of the relevant solids transport in Newtown Creek since sand transport in the Creek is spatially limited to areas directly adjacent to discharge locations. The sediment transport model is conservative in that it may lead to overestimation of chemical concentrations in the bed directly adjacent to discharge locations due to under-prediction of sand deposition in these localized areas. As sand settles more rapidly than other particles, the relatively slower settling speed used for modeling a single representative size class may under-predict local sand deposition. The sediment transport model potential to under-predict sand deposition near discharge locations could result in under-prediction of particle mass in these localized areas of the bed. This artifact of the single size class sediment transport model could over-estimate localized chemical concentrations calculated by a linked chemical transport model when reported on a solids-normalized basis. The potential for model over-estimation of chemical concentrations rather than under-estimation near discharge locations is the basis for describing the sediment transport model as conservative.

In addition to typical measured sediment transport modeling calibration targets, the sediment transport model calibration and validation for the periods 1/1/2012 to 9/30/2015 and 1/1/2016 to 9/30/2016 was further constrained by nutrient, dissolved oxygen, algal biomass, and organic carbon measurements.

4.4.3.4 Chemical Transport Modeling

A time-varying one-dimensional chemical-fate model, based on conservation of contaminant mass in the longitudinal flow direction was developed to perform transient evaluation of future contaminant concentrations under various point source reduction scenarios, starting with a clean sediment bed. The Newtown Creek water column of the model will be divided into several 1-D segments for mass balance by aggregating laterally and vertically the three-dimensional grid developed for the hydrodynamic and sediment transport model by HDR. For each segment, mass concentrations are assumed to be uniform across the width and depth of the segment. The sediment bed is represented as a one-dimensional single active unconsolidated layer that is assumed to be completely mixed due to bioturbation and mechanical processes. In the application of the chemical fate modeling for the OU2 FFS, the following assumptions were made: 1) initially this sediment bed is assumed to be clean to represent conditions just after a CERCLA remedy has been implemented for the entire creek, 2) complete source control for groundwater contaminant loadings, and 3) complete source control for Non Aqueous Phase Liquids loadings from lateral seeps and ebullition.

The one-dimensional chemical-fate model uses a higher order numerical scheme ULTIMATE QUICKEST (Leonard 1991) to solve the mass balance equation in the water column, and the Runge-Kutta 4^{th} Order scheme for the sediment bed. The model requires hydrodynamic flows, dispersion, volumes, suspended solids and organic carbon dynamics. These inputs will be provided by HDR's Estuarine and Coastal Ocean model and solids/organic carbon models as hourly data for the chemical fate model. Because of the aggregation of the three-dimensional model, a scale factor is applied to the longitudinal dispersion and the salinity results will be used to calibrate this scale factor.

The chemical-fate model will use estimates of point source loads from the various sources, and assume linear equilibrium partition between dissolved and particulate phases to simulate water column and sediment bed concentrations over time. The primary matrix of interest in the OU2 FSS is the surface sediment concentration in the top few centimeters of the bed. In general, the following summarizes how the modeling will be performed:

- Obtain 10-year hydrodynamic, sediment transport and organic carbon results from 3-D model Use the chemical-fate model to determine dispersion scale factor by calibration of salinity Determine appropriate external loads of the various COPCs, and chemical properties (e.g. partition coefficient, molecular diffusion), and atmospheric deposition loads.

- Simulate the equilibrium COPC surface sediment concentrations (in the top few cm of the sediment bed) for various scenarios of CSO controls. The 10-year hydrodynamic, sediment transport and organic carbon results will be recycled in the simulation as necessary to achieve the equilibrium surface sediment concentration.

The external loadings used in this model will be developed using data collected for the OU1 RI/FS where available. These include loads from East River, point sources and atmospheric deposition. Chemical loads from East River will be developed using the surface water data collected in the East River and at the mouth of Newtown Creek (first transect) for the OU1 RI/FS. For point sources, data collected under the OU1 RI/FS will be used. The point source loads will be developed such that the spatial heterogeneity is preserved where data is available

4.5 Community Involvement

There is an ongoing Community Involvement Plan (CIP)[3] for the Newtown Creek Superfund Site, which provides outreach information aimed to engage and inform the community, and it will be adhered to in the OU2 FFS process.

NYC will provide community involvement support to USEPA throughout the OU2 FFS in accordance with the USEPA Superfund Community Involvement Handbook, Office of Emergency and Remedial Response, USEPA 540-K-05-003, April 2005.

[3] https://semspub.epa.gov/work/02/510612.pdf

NYC will provide community relations support for public meetings to be held at a location to be specified in the vicinity of the Site.

NYC will also support the USEPA in conducting the following actions:

- Prepare one annual updated fact sheet;
- Hold an annual public meeting;
- Create and maintain an email list for stakeholders;
- Provide updates of changed contacts for the master CIP; and
- Use websites and social media to perform regular outreach.

4.6 Focused Feasibility Report

4.6.1 Draft Focused Feasibility Report

NYC will submit a Draft OU2 FFS Report pursuant to the OU2 FFS schedule presented in this Work Plan. The Draft OU2 FFS Report will include the following sections:

1) Executive Summary
2) Introduction
    - 2.1 Purpose of the Report
    - 2.2 Site Background
        - 2.2.1. Site Description
        - 2.2.2. Site History
        - 2.2.3. Current Conditions in the Creek
        - 2.2.4. Risk Assessments
            - 2.2.4.1. Baseline Human Health Risk Assessment
            - 2.2.4.2. Baseline Ecological Risk Assessments
        - 2.2.5. Conceptual Site Model
3) Development of RAOs
4) Identification of ARARs and TBCs
5) Screening and Development of Alternatives (Note: screening work performed as part of the LTCP development will be summarized and incorporated in the OU2 FFS)
6) Evaluation of CSO Remedial Alternatives
7) Assessment of COPCs in CSO solids and background
    - 7.1 Assessment of COPC loads in CSOs and background
    - 7.2 Assessment of impact of CSOs after in-Creek remediation has been completed
        - 7.2.1. Modeling Framework
        - 7.2.2. Hydrodynamic Modeling
        - 7.2.3. Sediment Transport Modeling
        - 7.2.4. Contaminant Modeling
    - 7.3 Analysis of Remedial Alternatives using the nine NCP criteria
    - 7.4 Comparative Analysis of Remedial Alternatives
8) Conclusions
9) References
10) Tables and Figures
11) Appendices

4.6.2 Final Focused Feasibility Report

After USEPA review of the Draft OU2 FFS Report, NYC will incorporate final USEPA comments and submit the Final OU2 FFS Report.

4.7 Post OU2 FFS Activities

The FFS will form the basis for USEPA to propose a remedial alternative for OU2 in a Proposed Plan, and subsequently select an alternative in a ROD. The selected remedial alternative must conform to the requirements identified in CERCLA, as amended, and to the NCP. CERCLA Section 121(d) requires that Superfund remedial actions attain ARARs unless specific waivers are granted and that remedial actions be protective of human health and the environment.

NYC will provide support to the USEPA post the OU2 FFS support including, but not limited to, public meeting support and preparation and review of presentation materials.

SECTION 5 - PROJECT MANAGEMENT APPROACH

5.1 Project Organization

The project organizational structure is provided in Figure 5.1-1.

5.2 Key Personnel

Ron Weissbard PE, Director of Superfund NYCDEP, is the project coordinator for the FFS. He will be responsible for administration of all actions by the Respondent required under the 2018 AOC. He will be responsible for executing the FFS within the established budget and schedule.

Dabeiba (Daby) Marulanda PhD, Superfund Manager, NYCDEP, is the alternate project coordinator for the FFS. She is responsible for project coordination when the coordinator is unavailable.

Keith Mahoney, PE, Acting LTCP Program Manager, NYCDEP, Office of the Agency Chief Engineer, will be responsible for description and evaluation of the engineering alternatives developed for OU2 FFS.

Jim Mueller, PE, Chief Engineer, NYCDEP, Office of the Agency Chief Engineer, will be responsible for description and evaluation of the engineering alternatives developed for OU2 FFS

Rebecca Tummon, Louis Berger, is the project manager for the contract under which the FFS will be executed. She will ensure implementation of quality procedures and is responsible for performance within the established budget and schedule.

Chitra Prabhu PE, HDR, is the technical lead for the FFS. She will be responsible for development of the Work Plan and the final FFS report; and other aspects of the day-to-day activities associated with the project.

Robin Miller, M.S. Env.E., HDR, is the lead modeler. She will be responsible for the appropriate interfacing of the three discipline-specific models required and the modeled representation of the selected remedial alternatives.

Solomon Gbondo-Tugbawa PhD., PE, Louis Berger, is the lead contaminant fate and transport modeler for the FFS. He will be responsible for the chemical model used for the FFS.

Stephen Ertman PhD, PE, HDR, is the lead sediment transport modeler for the project. He will be responsible for the sediment transport model developed during the LTCP and needed for the FFS.

Nicholas Kim M.S., HDR, is the lead hydrodynamic modeler for the project. He will be responsible for the hydrodynamic model developed during the LTCP and needed for the FFS.

Sharon Bailey, PE, Louis Berger, is the Quality Assurance/ Quality Control lead for the project. She will be responsible for evaluating the CSO alternatives using the NCP criteria and for conducting final quality assurance and quality control checks for the reports.

The technical discipline leads will oversee activities related to their expertise and provide their input, as needed, to the technical lead for the project.

5.3 Project Schedule

Project schedule for the OU2 FFS is developed in accordance with the schedule outlined in the statement of work attached to the 2018 AOC. Figure 5.3-1 shows the schedule for the OU2 FFS.

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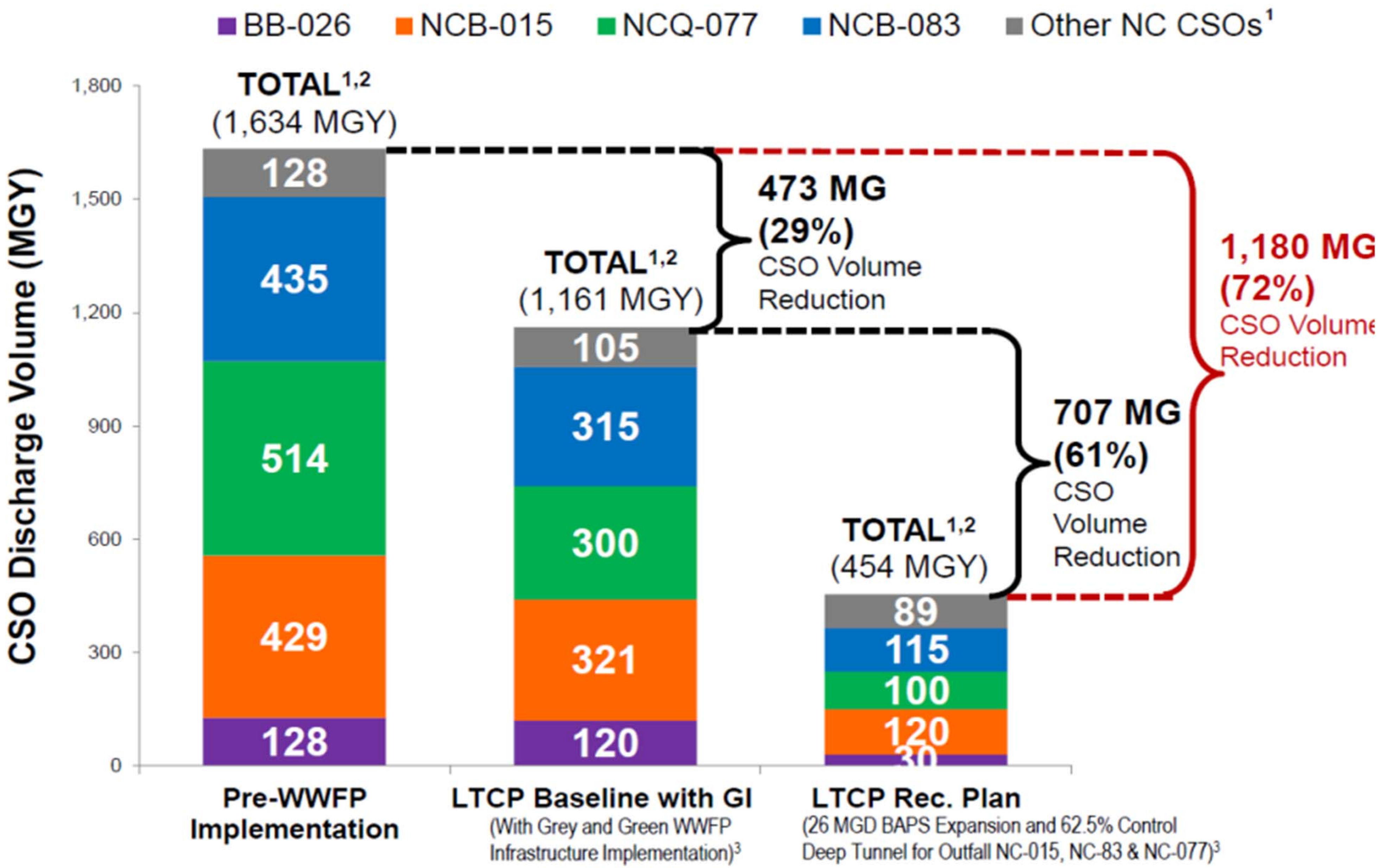
Figures

Figure 2.1-1 Study Area Location

Figure 2.2-1 LTCP Proposed Reduction in CSO Discharges



1) Other Newtown Creek CSOs include 17 other CSO outfalls in the NC and BB drainage areas that discharge into Newtown Creek
2) All CSO volumes were calculated using JFK 2008 rainfall in conjunctions with 2040 sanitary flows and satellite flyover impervious data
3) GI includes a 1.5% GI application rate on public properties and a 3% application rate on private property

Figure 5.1-1 - Organization Chart

USEPA

Caroline Kwan, Mark Schmidt, P.E and
Anne Rosenblatt
Project Coordinators

NYCDEP

Ron Weissbard, PE
Project Coordinator

Dabieba (Daby) Marulanda, PhD
Deputy Project Coordinator

Jim Muller, PE
Keith Mahoney, PE
Engineering Alternatives
Development

Rebecca Tummon, LEED AP - LB
Contract Project Manager

Chitra Prabhu, PE - HDR
Technical Project Manager

Solomon Gbondo-Tugbawa, PhD, PE - LB
OU2 FFS Contaminant Fate and Transport

Robin Miller, PE - HDR
Lead Modeler

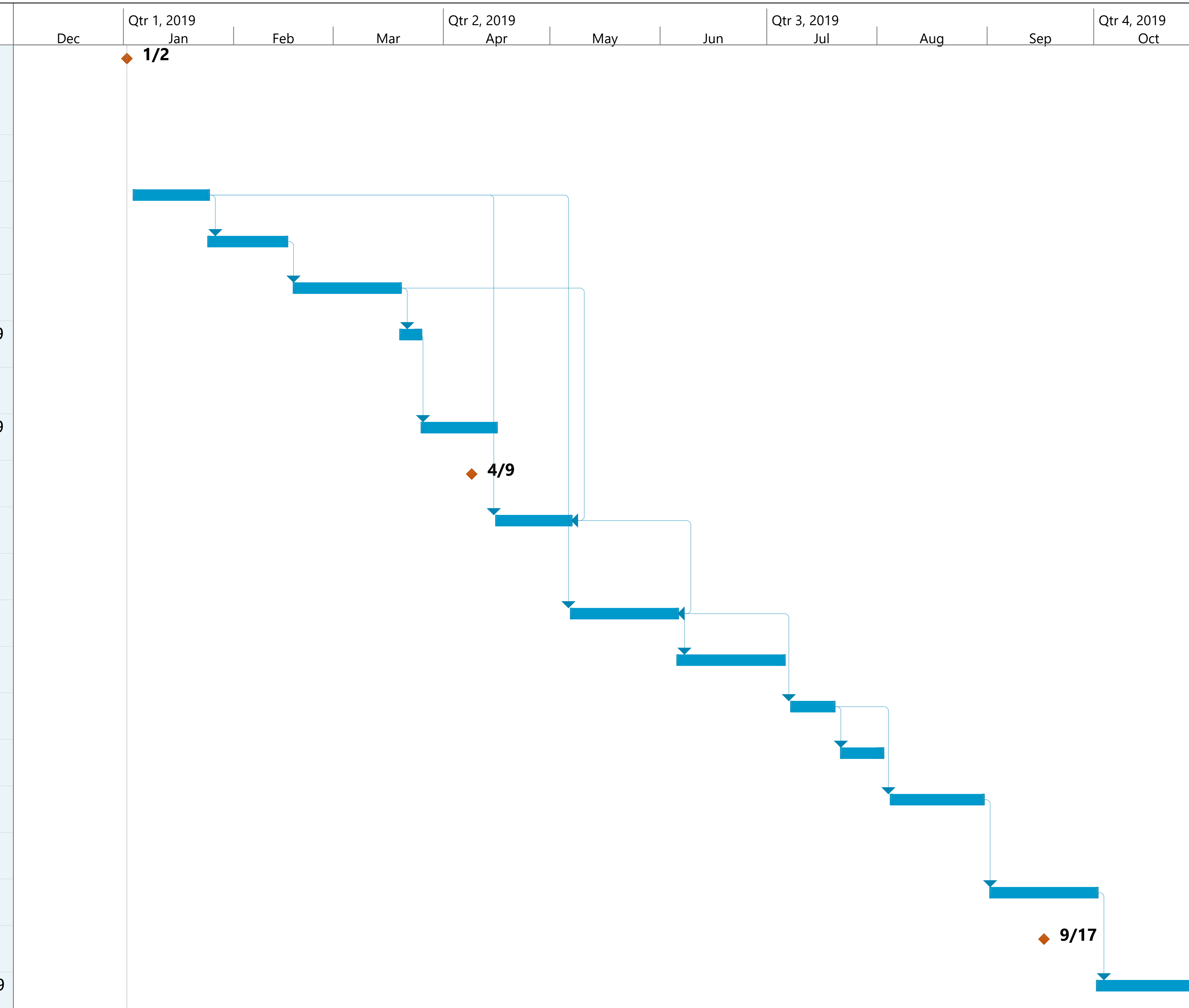
Sharon Bailey, PE - LB
CERCLA FFS Lead
Engineer, QA/AC

Nicholas Kim - HDR
Hydrodynamic modelling

Steve Ertman, PhD - HDR
Sediment Transport

Figure 5.3 - 1 Operable Unit 2 (OU2) Focused Feasibility Study (FFS) Schedule

Task	Duration (Days)	Calendar Days	Start	Finish
1 Signed Administrative Order on Consent (AOC) received by the City	0 days	0	Wed 1/2/19	Wed 1/2/19
2 Work Plan				
2.1 Submit Draft FFS Work Plan to EPA	15 days	21	Fri 1/4/19	Thu 1/24/19
2.2 EPA Comments on Draft Work Plan	16 days	22	Fri 1/25/19	Fri 2/15/19
2.3 Finalize the Work Plan	22 days	30	Mon 2/18/19	Tue 3/19/19
2.4 EPA Review of Final Work Plan	4 days	6	Wed 3/20/19	Mon 3/25/19
3 Evaluation of Alternatives				
3.1 Presentation	15 days	21	Tue 3/26/19	Mon 4/15/19
3.2 Submit Presentation to EPA	0 days	0	Tue 4/9/19	Tue 4/9/19
3.3 EPA Review of Presentation	15 days	21	Tue 4/16/19	Mon 5/6/19
4 FFS Report				
4.1 Submit Draft FFS Report to EPA	22 days	30	Tue 5/7/19	Wed 6/5/19
4.2 EPA Comments on FFS	22 days	30	Thu 6/6/19	Fri 7/5/19
4.3 Finalize the FFS Report	10 days	14	Mon 7/8/19	Fri 7/19/19
4.4 EPA Review of the Final FFS Report	10 days	14	Mon 7/22/19	Fri 8/2/19
5 Proposed Plan	20 days	30	Mon 8/5/19	Fri 8/30/19
6 Community Involvment				
6.1 Public Comment Period	22 days	30	Mon 9/2/19	Tue 10/1/19
6.2 Public Meeting	0 days	0	Tue 9/17/19	Tue 9/17/19
7 Record of Decision	20 days	30	Wed 10/2/19	Tue 10/29/19



Project: OU2 FFS Schedule
Date: Mon 3/18/19

Task | Milestone

Attachments

The City will be using the sewer system, hydrodynamic and sediment transport models developed for the purposes of LTCP to support the OU2 FFS. In addition the City has also developed a chemical fate and transport model to support the OU2 FFS. All these models have been peer reviewed by experts in the field. A brief description of the models and the associated data used to develop the models is provided below.

Hydrodynamic Model (LTCP)

The City has developed a hydrodynamic model for the LTCP to evaluate CWA parameters such as DO and pathogens. For the OU2 FFS evaluation of the expected future impact of CSO discharge on Newtown Creek after USEPA CERCLA remediation is completed, the City will apply hydrodynamic transport model outputs for use in chemical modeling. The hydrodynamic transport model outputs will be spatially aggregated to the resolution of the computational grid of the chemical model and passed to the chemical model. These outputs include: point source and groundwater discharge volumes and advection and diffusion volumetric exchanges between the aggregated model grid cells of the chemical recontamination potential model.

The three-dimensional and time-variable hydrodynamic transport model that will be used to develop these outputs is fully described elsewhere (City of New York, 2018), and has been peer-reviewed (Blumberg et al., 2017), and further vetted within the modeling community (Kim et al., 2018). The hydrodynamic transport model was presented to USEPA on October 21, 2016. This presentation included 43 slides, 2 animations, and 146 supplemental pages of model and measurement comparisons.

The source code underlying the Newtown Creek hydrodynamic model is ECOM. The hydrodynamic model computational grid including ten vertical sigma layers includes longitudinal and lateral segmentation in the Harlem River, Upper and Lower East River, and within Newtown Creek and its tributaries. Inside of Newtown Creek and its tributaries the hydrodynamic model grid segmentation is nearly identical to segmentation currently in use by USEPA for Newtown Creek RI modeling. The point source flows were estimated by the InfoWorks model for CSOs, stormwater, and direct drainage prepared for the LTCP and shared with USEPA for use in the RI/FS in a geo-neutral format. Groundwater flows were estimated by the City using the seepage data collected by the City for the Site. The hydrodynamic model considers the physical mixing induced by the aeration systems in English Kills and East Branch. The hydrodynamic model calibration and validation includes the periods 1/1/2012 to 9/30/2015 and 1/1/2016 to 9/30/2016, respectively. A listing of the measurements used to develop the hydrodynamic model outputs that will support the OU2 FFS evaluation is provided below.

<u>Data used for the hydrodynamic model:</u>

<u>Site-Specific Measurements for Specifying Forcing Functions and Other Inputs for Hydrodynamic Model Calibration (1/2012-9/2015) and Validation (10/2015-8/2016)</u>

Bathymetry

USEPA Approved NCG Digital Elevation Model (DEM)

- Composite of land elevation and bathymetry survey , 1-ft resolution.
- Land elevation data based on LiDAR survey, March 19, 2012
- Single-beam bathymetry (water depth) surveyed in Fall 2011

Open Boundaries

Tidal elevations:

- 6-minute observed data from the NOAA Battery and Kings Point stations
- Hourly elevations at Spuyten Duyvil calculated by NYCDEPs regional hydrodynamic model
- Water Temperature:
    - Hourly observed data from the NOAA Battery and Kings Point stations
    - Hourly water temp at Spuyten Duyvil calculated by regional hydrodynamic model
- Salinity:
    - Hourly salinity at the Battery, Kings Point, and Spuyten Duyvil calculated by regional hydrodynamic model

Other Model Forcing Functions

Ground Water Flows:

- USGS wells to determine recharge
- NYCDEP Ultraseep data to quantify GW flow through sediments
- MTA and NYCDEP historical reports to assess GW losses.

Point Source Inflows: Estimated from NYCDEP sewer system velocity measurements and mechanistic InfoWorks model using gridded radar rainfall measurements over the drainage area

Meteorological Forcing Functions: measurements from LaGuardia Airport and two Newtown Creek weather stations: Field Facility and National Grid.

- Field Facility: 11/28/2011 – 05/07/2013
- National Grid: 11/29/2011 – 03/25/2013

<u>Site-Specific Measurements for Hydrodynamic Model Calibration 1/2012-9/2015 and Validation 10/2015 -8/2016 Skill Assessment</u>

Velocity

USEPA Approved NCG ADCPs at 5 locations (March 2012 – March 2013)

USEPA Approved NCG ADCPs at 6 locations (July 2014 – May 2015)

NYCDEP ADCPs at 3 locations (June 2016 – July 2016) - 1 ADCP moved to new location after first 32 days

Temperature and Salinity

USEPA Approved NCG Moored YSI sensors

- Temperature July 2014 – October 2015 at 14 locations,
- Salinity July 2015 – October 2015 at 6 locations

NYCDEP LTCP2 & Superfund Receiving-Water Sampling

- continuous measurements at six locations (June – July 2016)
- grab samples June to August 2016, 4 four-day combined wet/dry-weather events, 14 stations in Newtown Creek & tributaries

NYCDEP Harbor Survey Program

- Monthly November to April, weekly May to October, 2012 - ongoing
- 4 Newtown Creek, 5 East River and 1 Harlem River stations within model domain

USEPA Approved NCG Vertical Sonde Profiles at 1-ft Increments

- Water-Quality Tidal Survey
    - July 2012, 3 locations (Newtown Creek mouth, mid-Creek, upper-Creek)
- Monthly Surface Water Analytical Chemistry
    - February 2012 to January 2013, 15 or 16 locations per month
- Benthic Surveys Ecological Surface Water Sampling
    - April to May 2012, and August 2012, 34 locations
    - Additional sonde measurement targeted 1-ft above sediment
- Fish Community Surveys
    - April 2012 (10 locations) and August 2012 (7 locations)
- Risk Assessment Surface Water Sampling
    - May & August 2014, 16 locations
- Benthic Fish Community Surveys
    - May to August 2014, near-bottom surface-water samples
    - For various sampling programs (Surface Sediment Triad – 45 locations, Surface Sediment Triad Bioaccumulation – 7 locations, Surface Sediment Benthic Community – 64 locations)
- Tissue Collection Program, June to September 2014 (2 or 3 times per month) - 10 locations
- East River Surface Water Sampling (inside of City model boundaries)
    - June 2014 to March 2015, monthly during flood tide
    - 5 locations
- Wet-Weather Surface Water Sampling
    - June 2014 to November 2015
    - Once or twice a month when rainfall predictions ≥ 0.5”
    - 11 locations
- Dry-Weather Surface Water Sampling
    - June 2014 to November 2015, Monthly
    - 13 locations
- River Keeper Water Quality Monitoring
    - May – October, approximately monthly, 2012 - ongoing
    - 2 Newtown Creek locations, 2 Harlem River locations, 2 East River locations

- Newtown Creek Alliance Water Quality Monitoring
    - April – September 2016
    - Irregular, every 3-7 days
    - 1 location in East River near Newtown Creek
    - 7 locations within Newtown Creek & tributaries
- USEPA-Approved NCG September 2016 Field Gas Ebullition Surveys, Pre /Post Survey Water Quality
    - September 16-19, 2016
    - 7 Newtown Creek Locations

Elevation

USEPA Approved NCG Field Facility and National Grid Measurements , February 2012 – March 2013

- Elevation from 2 NYCDEP ADCP sensors, June – July 2016

Sediment Transport and Organic Carbon Model (LTCP)

The City has developed a sediment transport and organic carbon model for the LTCP to evaluate CWA parameters such as DO and pathogens. For the OU2 FFS evaluation of the expected future impact of CSO discharge on Newtown Creek after USEPA CERCLA remediation is completed, the City will develop sediment transport model outputs for use in chemical modeling. The sediment transport model outputs that will be spatially aggregated to the resolution of the computational grid of the chemical model and passed to the chemical model include: point source organic and inorganic solids concentrations, total suspended solids, the fraction of particulate organic carbon in the water column and sediment bed, depositional flux, and erosional flux.

The three-dimensional and time-variable sediment transport model that will be used to develop these outputs is fully described elsewhere (City of New York, 2018) and has been peer-reviewed (Blumberg et al., 2017). The source code underlying the Newtown Creek sediment transport model is RCA. Like the hydrodynamic model, the sediment transport model computational grid includes ten vertical sigma layers and longitudinal and lateral segmentation in the East River, but omits the Harlem River and a portion of the Upper East River. Within Newtown Creek and its tributaries, the sediment transport model computational grid segmentation is identical to the hydrodynamic model grid segmentation and is nearly identical to segmentation currently in use by U S EPA for Newtown Creek RI/FS modeling. The sediment transport model also includes sediment bed segmentation matching the longitudinal and lateral resolution of the water column for a 10 cm depth.

The sediment transport model includes a dissolved oxygen/eutrophication model which calculates primary produced (algal) and detrital particulate organic carbon and dissolved organic carbon. The model calculations include inorganic suspended solids modeled as one cohesive size class, combined organic-inorganic flocs. The single cohesive grain size applied focused on the transport of point-source inorganic and carbonaceous solids, appropriate for the OU2 FFS. The model represents most of the relevant solids transport in Newtown Creek since sand transport in the Creek is spatially limited to areas directly adjacent to discharge locations. The model is therefore conservative in that it may lead to overestimation of modeled chemical concentrations in the bed directly adjacent to discharge locations due to under-prediction of sand deposition in these localized areas. In addition to typical measured sediment transport modeling calibration targets, the sediment transport model calibration and validation for the periods 1/1/2012 to 9/30/2015 and 1/1/2016 to 9/30/2016 was further constrained by nutrient, dissolved oxygen, algal biomass, and organic carbon measurements. A list of the measurements used to develop the sediment transport model outputs supporting the OU2 FFS evaluation is provided below.

Data used for the sediment transport and hydrodynamic model:

SITE-SPECIFIC MEASUREMENTS FOR SPECIFYING MODEL OPEN BOUNDARY CONDITIONS FOR CALIBRATION AND VALIDATION (1/2012 TO 9/2015 AND 1/2016 TO 9/2016)

NYCDEP Harbor Survey Program, Monthly November–April, weekly May–October :Relevant stations

- Harlem River – one station, H3
- Upper East River – one station E4
- Upper Bay – one station, N5

- Long-term monthly averages for 2012 through 2015 and thru 8/2016, WQ parameters
  - Temperature
  - Salinity
  - NH3, NO2+NO3, TKN
  - TP
  - SiO2
  - Chl *a*
  - DOC
  - DO
  - TSS

SITE-SPECIFIC MEASUREMENTS FOR SPECIFYING MODEL POINT-SOURCE (CSO /SW / WPCP) CHARACTERISTICS FOR CALIBRATION AND VALIDATION (1/2012 TO 9/2015 AND 1/2016 TO 9/2016)

NYCDEP Discharge Monitoring Reports

- January 2012 through September 2015
- WPCP treated effluent
  - Newtown Creek WPCP (East River and Whale Creek outfalls)
  - Red Hook WPCP (East River outfall)
- WQ parameters
  - Grab samples
    - Temperature
    - DO
  - 24-h composites
    - NH3, NO2+NO3, TKN
    - PO4, TP
    - TSS
    - CBOD5

NYCDEP Newtown Creek Point-Source Sampling August 2014 through December 2015

- 17 wet-weather & 3 dry-weather events
- 14 sample locations (not all locations sampled each event)
  - CSO, SW, WPCP influent, NCB-002 WPCP treated effluent
- Composited samples
  - DOC, POC, fraction organic carbon (solids)
  - TSS
  - Grain size

USEPA Approved NCG Phase 2 Point-Source Sampling , June 2014 to November 2015

- 29 locations (CSO, SW, WPCP, treated groundwater effluent)
- Wet (composited) & dry weather (discrete)
- Conventional parameters
  - NH3, NO2+NO3, TKN (total & dissolved)
  - TP, PO4
  - BOD5
  - TSS

NYCDEP LTCP II Point-Source Sampling, July to October 2016

- 3 CSO outfalls (BB-026, NCQ-077, NCB-083)
- 2 SW outfalls (NCB-631, NCB-629)
- 4 wet-weather events
  - Up to 5 samples per location every 30 minutes during discharge
- Sonde parameters
  - Temperature, Salinity, DO
- Grab-sample parameters
  - BOD5
  - NO2, NO3, NH4 TKN
  - TSS

SITE-SPECIFIC MEASUREMENTS FOR COMPARISON TO MODEL RESULTS FOR CALIBRATION / VALIDATION (1/2012 TO 9/2015 AND 1/2016 TO 9/2016)

NYCDEP Harbor Survey Program, Monthly November–April, weekly May–October

- Relevant stations
  - Lower East River – one station, E2
  - Newtown Creek – four stations, NC0, NC1, NC2, NC3
- WQ parameters
  - Temperature
  - Salinity
  - NH3, NO2+NO3,TKN
  - PO4, TP
  - SiO2
  - Chl *a*
  - DOC
  - DO
  - TSS

USEPA Approved NCG Phase 1 TSS Grab Samples

- 03/2012 through 06/2012 – 5 stations, 3 depths, once or twice a month
- 09/2012 through 11/2012 – 5 stations, 3 depths, once or twice a month
- 01/2013 through 02/2013 – 5 stations, 3 depths, once or twice a month

USEPA Approved NCG Phase 1 Water-Quality Tidal Survey , 6 July 2012 (13-h survey at 2-h increments)

- 3 stations (Newtown Creek mouth, mid, upper)
- Vertical sonde profiles at 1-ft increments
  - Temperature, Salinity, DO

USEPA Approved NCG Phase 1 Monthly Surface-Water Analytical Chemistry, 02/2012 through 06/2012 (16 stations), 07/2012 through 08/2012 (15 stations), 09/2012 through 01/2013 (16 stations)

- Vertical sonde profiles at 1-ft increments
    - Temperature, Salinity, DO
- Grab samples (up to 3 depths per station)
    - DOC, POC
    - NH3, NO2+NO3, TKN
    - TP
    - BOD5
    - TSS

USEPA Approved NCG Phase 1 Benthic Surveys – Ecological Surface-Water Sampling , 14 April to 4 May 2012 and 13 August to 30 August 2012, 34 stations

- Vertical sonde profiles at 1-ft increments
    - Temperature, Salinity, DO
- Grab samples targeted 1-ft above sediment
    - DOC, POC
    - NH3, NO2+NO3 (total & dissolved), TKN (total & dissolved)
    - TP (total & dissolved)
    - TSS
- Additional sonde measurement targeted 1-ft above sediment
    - Temperature, Salinity, DO

USEPA Approved NCG Phase 1 Fish Community Surveys, April (10 stations)**,** August 2012 (7 stations)

- Vertical sonde profiles at 1-ft increments
    - Temperature, Salinity, DO

USEPA Approved NCG Phase 2 Risk Assessment Surface Water, May & August 2014, 16 stations

- Vertical sonde profiles at 1-ft increments
    - Temperature, Salinity, DO
- Grab sample parameters (near surface & near bottom)
    - DOC, POC
    - NH3, NO2+NO3, TKN
    - TP
    - BOD5
    - TSS

USEPA Approved NCG Phase 2 Benthic-Fish Community Surveys, May through August 2014

- Near-bottom surface-water samples
- Various sampling programs
    - Surface Sediment Triad – 45 stations
    - Surface Sediment Triad, Bioaccumulation – 7 stations
    - Surface Sediment Benthic Community – 64 stations
- Vertical sonde profiles at 1-ft increments
    - Temperature, Salinity, DO
- Grab-sample parameters
    - DOC, POC
    - NH3, NO2+NO3, TKN
    - TP
    - TSS

USEPA Approved NCG Phase 2 Tissue Collection Program, June - September 2014 (2-3 times per month)

- 10 stations
- Vertical sonde profiles at 1-ft increments
  - Temperature
  - Salinity
  - DO

USEPA Approved NCG Phase 2 East River Surface Water Sampling (inside of City model boundaries), June 2014 to March 2015, Monthly during flood tide. 5 stations at 3 depths (near surface, mid depth, near bottom)

- Vertical sonde profiles at 1-ft increments
  - Temperature
  - Salinity
  - DO
- Grab-sample parameters
  - DOC, POC
  - NH3, NO2+NO3, TKN
  - TP
  - BOD5
  - TSS

USEPA Approved NCG Phase 2 Wet-Weather Surface Water Sampling June 2014 to November 2015

- Once or twice a month when rainfall predictions ≥ 0.5”, 11 stations
- Vertical sonde profiles at 1-ft increments
  - Temperature, Salinity, DO
- Grab-sample parameters (near surface & near bottom)
  - DOC, POC
  - NH3, NO2+NO3, TKN
  - TP
  - BOD5
  - TSS (7 stations only)

USEPA Approved NCG Phase 2 Dry-Weather Surface Water Sampling, June 2014 to November 2015

- Monthly
- 13 stations
- Vertical sonde profiles at 1-ft increments
  - Temperature, Salinity, DO
- Grab-samples (near-surface & near-bottom)
  - TSS

NYCDEP LTCP2 Receiving-Water Sampling, July to October 2016

- 4 four-day combined wet/dry-weather events
- 14 stations in Newtown Creek & tributaries
- 6 continuous (up to 60 days) sonde installations
- Discrete & continuous sonde parameters
  - Temperature, Salinity, DO
- Grab-sample parameters:
  - DOC, POC
  - TSS
  - Chl *a*

RiverKeeper Water Quality Monitoring, May – October, approximately monthly, 2012 - ongoing

- 2 Newtown Creek stations, 2 Harlem River stations, 2 East River stations
- Sample parameters:
    - Temperature
    - Salinity
    - DO
    - Chl *a*
    - Rainfall (4 days, day of sampling and 3 days prior)

Newtown Creek Alliance Water Quality Monitoring

- April – September 2016
- Irregular, every 3-7 days
- 1 location in East River near Newtown Creek
- 7 locations within Newtown Creek & tributaries
    - Salinity
    - Temperature
    - Nitrate
    - Phosphate
    - DO concentration

<u>SITE-SPECIFIC SEDIMENT CHARACTERISTICS MEASUREMENTS FOR COMPARISON TO MODEL RESULTS FOR CALIBRATION / VALIDATION (1/2012 TO 9/2015 AND 1/2016 TO 9/2016)</u>

USEPA Approved NCG Phase 1 Sedflume Core Collection, 22 March 2012

- 5 stations
- 5 layers (inconsistent sizes) down to ~15–20-cm depth
- Measured parameters
    - Critical erosion shear stress & erosion rate
    - Bulk density & water content
    - Organic mass fraction (by combustion)
    - Grain-size distribution (laser diffraction with sonication and dispersant)

USEPA Approved NCG Phase 1 Surface Sediment Collection

- 16 April through 11 May 2012 (133 stations)
- 20 August through 22 August 2012 (34 stations)
- 11 July through 12 July 2012 (6 stations)
- Target layer: 0–15 cm
- Conventional parameters (N.B., not all parameters at all stations)
    - TOC
    - NH3, NO2+NO3, TKN
    - TP
    - Bulk density, percent solids, moisture content
    - Grain size (1”, 0.75”, 0.5”, 0.375”, 4750 μm, 2000 μm, 850 μm, 425 μm, 250 μm, 150 μm, 75 μm) – N.B., sieve mesh sizes were generally too coarse for sediment

USEPA Approved NCG Phase 1 Subsurface Sediment Collection, May through July 2012 (98 stations)

- Target core depth 20 ft, Target intervals: 15–60 cm, 60–100 cm, 100–200 cm, 200–300 cm, 300–400 cm, 400 cm–native soil or 400–500 cm, 500 cm–native soil, native soil
- Conventional parameters (N.B, not all parameters for all samples)
  - <u>TOC - Corrected</u>
  - NH3, NO2+NO3, TKN
  - TP
  - Bulk density, percent solids, moisture content
  - Grain size (2.5”, 1.5”, 1”, 0.75”, 0.5”, 0.375”, 4750 μm, 2000 μm, 850 μm, 425 μm, 250 μm, 150 μm, 75 μm)

USEPA Approved NCG Post-Hurricane Sandy Surface Sediment Collection, February 2013 - 30 stations

- Target layer: 0–15 cm
- Conventional parameters
  - <u>TOC - Corrected</u>
  - Percent solids
  - Grain size (1”, 0.75”, 0.5”, 0.375”, 4750 μm, 2000 μm, 850 μm, 425 μm, 250 μm, 150 μm, 75 μm) – N.B., sieve mesh sizes were generally too coarse for sediment

USEPA Approved NCG Phase 2 Surface Sediment Collection, May through August 2014

- Target layer: 0–15 cm
- Various sampling programs
  - Point Source – 27 stations near point source discharges
  - Occupational Exposure – 8 stations
  - Sediment Mound – 4 stations
  - Additional Benthic Community – 48 stations
  - Additional Risk Assessment – 15 stations
  - Additional Nearshore – 23 stations
  - Confirmation of Contaminant Distribution – 16 stations
  - Surface Sediment Triad – 21 stations
  - Surface Sediment Triad, Additional Benthic Community – 4 stations
  - Surface Sediment Triad, Bioaccumulation – 7 stations
  - Surface Sediment Triad, Bioaccumulation, Additional Benthic Comm. – 12 stations
- Conventional parameters (N.B., not all parameters at all stations)
  - TOC, Soot C
  - NH3, NO2+NO3, TKN
  - TP
  - Bulk density, percent solids, moisture content
  - Grain size (0.5”, 0.375”, 4750 μm, 2000 μm, 850 μm, 425 μm, 250 μm, 150 μm, 75 μm) – N.B., sieve mesh sizes were generally too coarse for sediment

USEPA Approved NCG Phase 1 and Phase 2 Radiochemistry (2012-2015)

- 42 subsurface cores: 30 with 100-400 cm depth, 12 with 60-cm depth
- 15 – 27 samples per deep core on average
- 7 samples per 60-cm core
- Pb-210, Cs-137 (for deep cores only), TOC, dry density

NYCDEP LTCP2 SOD Sampling , July to August 2016, 2 events

- 6 stations in Newtown Creek main stem and tributaries

1D Chemical Fate and Transport Model:

The one-dimensional chem-fate model uses a higher order numerical scheme ULTIMATE QUICKEST (Leonard 1991) to solve the mass balance equation in the water column, and the Runge-Kutta 4th Order scheme for the sediment bed. The model requires hydrodynamic flows, dispersion, volumes, suspended solids and organic carbon dynamics. These inputs will be provided by HDR's ECOM model and solids/organic carbon models as hourly data for the chemical fate model. Because of the aggregation of the three-dimensional model, a scale factor is applied to the longitudinal dispersion and the salinity results will be used to calibrate this scale factor.

The chem-fate model will use estimates of point source loads from the various sources, and assume linear equilibrium partition between dissolved and particulate phases to simulate water column and sediment bed concentrations over time. In general, the following summarizes how the modeling will be performed:

- Obtain 10-year hydrodynamic, sediment transport and organic carbon results from 3-D model
- Using the chemfate model determine dispersion scale factor by calibration of salinity
- Determine appropriate external loads of the various COPCs, and chemical properties (e.g. partition coefficient, molecular diffusion), and atmospheric deposition loads.
- Starting with a clean bed assumption, simulate a minimum of 30 years of future COPC surface sediment concentrations by repeating the hydrodynamics and sediment transport result in a minimum 3 cycles for various scenarios of CSO controls.

Data used for chemical fate and transport model:

USEPA Approved NCG Phase 2 Point-Source Sampling, June 2014 to November 2015
- CSO, Stormwater, treated groundwater effluent
- Chemical Parameters
    - Wet Weather data collected for all the contaminants of potential concern (COPC) identified in the BERA and BHHRA.
    - Whole water and split phase data.

USEPA Approved NCG Phase 1 and Phase 2 Dry-Weather Surface Water Sampling for East River and first transect in Newtown Creek
- Chemical Parameters
    - Data collected for all the COPCs identified in the BERA and BHHRA.
    - Whole water data.

NJDEP - New Jersey Atmospheric Deposition Network – Reinfelder 2004
- Chemical Parameters
    - PAHs & Metals

Atmospheric Deposition of PCBs and PAHs to the New York/New Jersey Harbor Estuary – Totten 2006
- Chemical Parameters
    - PCBs

USEPA Approved NCG Phase 2 Groundwater Data
- Chemical Parameters
    - Data collected for all the contaminants of potential concern (COPC) identified in the BERA and BHHRA
    - GW WW data collected from the native and soft sediment interface.

<u>Sewer System Model (InfoWorks)</u>:

To evaluate the expected future impact of CSO discharge on Newtown Creek after USEPA's CERCLA remediation has been completed, estimates of point source chemical loadings will be developed. Point source chemical loadings will be estimated based upon the CSO, stormwater, and direct drainage flows to the Creek calculated by the City's time-variable sewer system model for Newtown Creek (City of New York, 2018). The City's sewer system model for Newtown Creek was previously shared with USEPA in a geo-neutral format for use in the OU1 RI/FS. The CSO, stormwater, and direct drainage flows calculated with the City's sewer system model for Newtown Creek are passed to the hydrodynamic, sediment transport, and chemical transport models and are used for loading calculations.

The source code underlying the City's sewer system model for Newtown Creek is the commercial software product, InfoWorks CS™ (IW) version 10.5. The application of InfoWorks to the Newtown Creek and Bowery Bay WWTP service areas draining to Newtown Creek includes modeling: plant headworks, interceptors, branch interceptors, major trunk sewers, all sewers greater than 48 inches in diameter plus other smaller, significant sewers, and control structures such as pumping stations, diversion chambers, tipping locations, regulators, and tide gates. While InfoWorks development and calibration for Newtown Creek spanned many years, the most recent validation in 2015 included collection of additional flow meter and inclinometer measurements. The approach to analyzing the data from this flow metering program followed the approach documented in the peer-reviewed report published by the Water Environment Research Federation (WERF) in 2015 entitled *NYCDEP CSO Metering Pilot Study.*

After the 2015 validation of Newtown Creek InfoWorks, it was necessary to further update existing condition and future baseline versions of the model as new information became available such as infrastructure modifications and drainage area refinements described in City of New York, 2018. The baseline model as applied for the LTCP will be used for future impact assessment purposes. A listing of the measurements as described in City of New York 2018 used to develop the sewer system model outputs that will support the OU2 FFS evaluation is provided below.

Data used for Newtown Creek Sewer System Model:

Flow Meters (2014-2015, 2009)

- 2014-2015 – CSO BB-026, CSO NCB-015, CSO NCB-083, CSO NCQ-029, and CSO NCQ-077, each having 3 to 10 meters and 3 to 11 sensors
- 2009 – CSO NCB-015, CSO NCB-014

Inclinometers (2014-2015)

- CSO BB-026 and CSO NCB-015

Supervisory Control and Data Acquisition (SCADA) Data (2015)

- CSO BBL-026, CSO NCQ-077, and CSO NCB-014, each with 4 sensors, CSO BBL-026 had a conductivity meter

Pumping Station and WWTP Operations Data

- Wet- and dry- weather flow information

Rainfall (March 2014 to April 2015)

- NEXRAD radar and 31 ground-based precipitation gauges

Tides

- Astronomical tide-level estimates modified to reflect 30-hour meteorological residuals at nearby NOAA reference station

Soil and Infiltration Data

- NYC Water and Soil Conservation Service, pervious surface coverage

Impervious Area Satellite Imagery

- Columbia University, 2.4 meter pixel resolution

Evapotranspiration

- Cornell University Northeast Regional Climate Center, hourly estimates
- NOAA climate stations at JFK, EWR, CPK, LGA, 2000 to 2011

Pipe Sedimentation Inspections

- Citywide inspection and cleaning program
- Inspection at CSO NCQ-077

Sewer Maps, Infrastructure Field Inspections and Dye Testing

- New Calvary Cemetery, LIRR property, and First Calvary Cemetery storm sewers
- CSO NCB-015, Regulator B-01
- CSO NCB-083, sewers between CSO NCB-083 and CSO NCB-015
- CSO NCQ-029
- CSO NCQ-077
- BB-031, Regulator L-24 and Regulator L-29A
- BB-038, Regulator L-34
- BB-046, Regulator L-26
- BB-047, Regulator L-28
- NCM-050, Regulator M-19
- NCM-079, Regulator M-8